REMARKS

Reconsideration and allowance of the subject application are respectfully requested. Claims 1-4 and 6-33 are pending, claims 12-18 and 21-25 have been withdrawn as pertaining to non-elected restricted claims. Claims 1, 9, 10, 19, and 20 are independent, claims 1-4, 6-11, 19, and 20 have been amended and claims 26-33 have been added, and claim 5 has been canceled.

Rejection Under 35 U.S.C. § 112, First Paragraph

Claim 19 stands rejected under 35 U.S.C. § 112, first paragraph as allegedly containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the specification was filed, had possession of the claimed invention. This rejection is respectfully traversed.

The Examiner has requested that the Applicants point out where in the specification a description of a "sampling plane generator" is provided. Applicants direct the Examiner's attention to page 14 of the specification specifying the function of a sampling plane generator, which partially states:

> a sampling plane generator which produces a continuous sample data train of a sampling plane of a specific angle by shifting the phase of or interpolating the sample data derived from the multiple scanning cycles,

and with regard to continuous sample data, as stated on page 23:

> the invention is also applicable to cases where the sample data are oblique continuous sample data or parallel sample data obtained by simultaneously sampling signals picked up by all the receiving elements

Finally, with reference to the operation of a sample data generating circuit 115 in accordance with the present invention, the specification on page 57 states:

> Regardless of whether the sample data trains entered from the buffer RAMs 111, 112 are oblique steplike sample data, simultaneously sampled data or oblique continuous sample data, delay and phase-shifting coefficients for correcting sampling timing may be used.

Applicants contend the above-passages support description of the subject matter of the above-identified application which has now been moved to dependent claim 27. Therefore, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection under 35 U.S.C. § 112, first paragraph.

Prior Art Rejections

1. Rejection under 35 U.S.C. § 102 (b) based on *Jarman et al.*.

Claim 20 stands rejected under 35 U.S.C. §102(b) as being anticipated by *Jarman et al.* (U.S. Patent No. 4,313,184). This rejection is respectfully traversed.

Claim 20 is directed to towards a receiving beam-forming apparatus which repeatedly samples echo signals received by multiple ultrasonic transducer elements at a specific scanning frequency and forms a receiving beam using sample data obtained by sampling the echo signals in multiple scanning cycles.

An example of using various scanning cycle, Figure 2 of the present application illustrates an application of the invention to the formation of a receiving beam using a linear array. Figure 2 is a sampling time chart showing a case in which 15 scanning cycles (N-7 to N+7) of in-phase (I) and quadrature (Q) data sampling operations, where each scanning cycle, corresponding to four times the wavelength, are repetitively conducted using 8 transducer elements at a time from left to right of the linear array in a

step like form. The receiving beam is not formed by using sample data obtained from all the transducer elements in the same scanning cycle, instead the receiving beam is formed by using sample data while shifting the scanning cycles of the successive 8 transducer elements. This approach makes it possible to increase the expanse of the transducer elements simultaneously hit by the incoming waves from the extend A to the extend B (Figure 2; specification pages 20-21).

Jarman describes a side scan sonar system where the period of scanning frequency is related directly to the scanning arc angle of the sonar beam (Jarman, col. 4, ll. 3-5). A fixed beam is formed by sampling, at the scan frequency, the detected received sonar signals (Jarman, col. 4, ll. 5-7). A sampling signal can be derived from the scanning frequency signal by means of suitable time delays such that the sample can occur at any required point in the scanned arc and can be of any duration (Jarman, col. 4, ll. 8-12). Side scan operation is achieved by sampling the scanning beam as it passes through a bearing at substantially 90 degrees to the direction of travel. (Jarman, col. 4, ll. 22-24).

The Examiner alleges that Jarman col. 4, lines 3-12 anticipates the present invention defined by claim 20. In Jarman the scanning frequency is analogous to a sweep frequency of the scanning beam, whereas in the present invention defined by claim 20 it is clearly understood that the scanning frequency refers to sampling frequency. In Jarman the sampling frequency is a function of the sweep frequency hence the return beam will have a predetermined source direction. In claim 20, the device is determining the source direction by using sample data obtained by sampling the echo signals in multiple scanning cycles. Applicants respectfully request that the

Examiner point to the relevant portions of Jarman that encompass all of the elements of the present invention defined by claim 20.

For anticipation under 35 U.S.C. § 102 "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California 814 F.2d 628, 631, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987)(M.P.E.P. 2131). For reasons stated above applicants assert that all of the elements of claim 20 fail to be set forth in the embodiment shown in Jarman and, thus, Jarman fails to anticipate claim 20.

In view of the above, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection under 35 U.S.C. § 102 based on Jarman.

2. Rejection under 35 U.S.C. § 103 (a) based on Wright et al. in view of Gilmour

Claims 1-4 and 6-11 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Wright et al. (U.S. Patent No. 5,667,373) in view of Gilmour (U.S. Patent No. 4,262,344). This rejection is respectfully traversed.

The Examiner alleges that the difference between independent claims 1, 9, and 10 and Wright is the claimed selection of sampling data from different scanning cycles. The Examiner then alleges that Gilmour teaches the selecting of sampling data from multiple scanning cycles and suggests that the technique is well known especially in side looking sonar applications (Office Action, 18 December 2003, page 3). Applicants contest the Examiners characterization of Wright and Gilmour.

In the Applicants' response of 26 September 2002, Applicants explained differences between Gilmour and the present claims 1-4 and 6-11. The Examiner in the Response to Arguments of the present Office Action took the position that it was unclear

how the claim limitations were supported in Figure 2 of the present invention. Applicants draw the Examiners attention to amended independent claims 1, 9, and 10 where the forming of the receiving beam can be achieved by less than full illumination of the ultrasonic transducers ('p' < 'n') by the acoustic wave responsible for the signals received by the individual ultrasonic transducer elements, an embodiment of which is shown in Figure 2.

The Gilmour patent discloses a side looking sonar beam forming apparatus that generates a plurality of sets of radially extending beams in a chirp Z-transform sonar beam former. More particularly, we would like to point out Figure 2 of the preferred embodiment of the present invention depicts six waves having a short duration which do not touch on all the transducer elements at the same one time ('p' < 'n'). This is very different from Figures 5A through 5D in the Gilmour patent that uses waves having a long duration, which <u>touch on all of the transducer elements at one time.</u> In Figures 5A through 5D of Gilmour, the transducer is assumed to be made up of an infinite number of infinitesimal elements. In Figure 5C, the wave direction associated with the beam produces a plurality of maximum and minimum voltages along the length of the transducer resulting in the waveform having twice the frequency of the waveform. Thus Gilmour fails to show, suggest, or teach where the forming of a receiving beam can be achieved by less than full illumination of the ultrasonic transducers by the acoustic wave responsible for the signals received by the 'p' ultrasonic transducer elements.

Wright et al. discloses a method for forming a coherent image from a transmit beam. The preferred method in Wright requires sampling from multiple receive signals, acquired simultaneously pairwise, each pair associated with a single transmit beam (col.

7, ll. 41-44). Beam to beam coherency is required for predictable results in Wright when combining coherent samples from distinct receive beams (Wright, col. 8, ll. 32-34). More particularly, an ultrasonic diagnostic apparatus is disclosed which is constructed to form a synthetic scan line between transmit scan lines. A transmit scanline is a line on which an associated transmit beam is presumed to lie. Synthetic scan lines are scan lines that are distinct from any receive scan lines and/or any transmit scan lines (Wright, Figures 6A-6C). Wright is concerned with the formation of an image.

Applicants request that the Examiner point out the specific sections in Wright that teach, show, or suggest to one of ordinary skill in the art that the forming of the receiving beam can be achieved by less than full illumination of the ultrasonic transducers by the acoustic wave responsible for the signals received by the individual ultrasonic transducer elements.

With respect to claim 10, Applicants request that the Examiner point out the passages in Gilmour and Wright where the signal lines are less than the number of ultrasonic transducer elements, where the scanning cycle is dependent on the scanning frequency, and the receiving beam is found using selected complex-related data.

To establish a *prima facie* case obviousness under 35 U.S.C. § 103, the Examiner has the burden of meeting the following three basic criteria: (1) the prior art must teach or suggest all of the claim limitations; (2) there must be a reasonable expectation of success; and (3) there must be some suggestion or motivation, either in the art or knowledge generally available to one of ordinary skill in the art to modify the reference or to combine teachings (M.P.E.P. § 2143)(emphasis added).

As discussed above, the Examiner has failed to provide references that show, suggest, or teach the elements of independent claims 1, 9, and 10.

Applicants have already explained why Gilmour and Wright fail to teach or suggest the invention of independent claims 1, 9, and 10. Since claims 2-4, 6-8 and 11 each depend, either directly or indirectly, from one of claim(s) 1, 9, and 10, claims 2-4, 6-8 and 11 are allowable at least for the reasons generally expressed above with respect to claim(s) 1, 9, and 10.

In view of the above, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection of claims 1-4, 6-11 under 35 U.S.C § 103(a).

New Claims

New claims 26-33 are added to this application and further define the inventive features supported by the present application. Favorable consideration of these claims is earnestly solicited.

CONCLUSION

In view of the above amendments and remarks, Applicants respectfully request reconsideration and withdrawal of the formal objections and rejections to the claims, and the rejections based on prior art. Because all claims are believed to define over prior art of record, Applicants respectfully request an early indication of allowability.

Pursuant to 37 C.F.R. §§ 1.17 and 1.136(a), Applicant(s) respectfully petition(s) for a two (2) month extension of time for filing a reply in connection with the present application, and the required fee of $$410.00 is attached hereto.

If the Examiner has any questions concerning this application, the Examiner is requested to contact the undersigned at (703) 205-8000 in the Washington, D.C. area.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayments to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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Attachments: Marked-up Version of the claims

MARKED UP VERSION TO SHOW CHANGES MADE

IN THE CLAIMS

The claims have been amended as follows:

1. (Amended) A receiving beam-forming method comprising [the steps of]:

arranging 'n' ultrasonic transducer elements into a predetermined form;

dividing [a] the [plurality of] ultrasonic transducer elements [arranged in an arc-shaped form] into multiple blocks [according to directions in which receiving beams are formed], where 'p' ultrasonic transducer elements are illuminated by an acoustic signal, where 'p' ≤ 'n';

repeatedly sampling signals received by [the individual] 'p' ultrasonic transducer elements at a specific scanning frequency;

forming sample data for the blocks for a scanning cycle, where a scanning cycle is dependent on a wavelength of the acoustic signal;

selecting sample data [derived from different scanning cycles for the individual blocks]; and

forming the receiving beams using the selected sample data.

2. (Amended) The receiving beam-forming method according to claim 26 [1], wherein the signals received by the [multiple] 'p' ultrasonic transducer elements are pulse signals whose pulselength is shorter than the extent of the [multiple] 'n' ultrasonic transducer elements arranged in the [arc-shaped] predetermined form as measured along the direction of [each of the] a receiving beam[s].

3. (Amended) The receiving beam-forming method according to claim 26 [1], wherein the acoustic signal [signals received by the multiple ultrasonic transducer

elements are] is composed of growing waves whose amplitude gradually increases or damped waves whose amplitude gradually decreases.

4. (Amended) [A] The receiving beam-forming method [in which a plurality of ultrasonic transducer elements arranged in an arc-shaped form as recited in] of claim 26 [1], wherein the arc is [are] obtained by selecting an arc-shaped part of [multiple ultrasonic transducer elements which are arranged in] a cylindrical [circular] form, wherein the receiving beam-forming direction is rotated by [successively] switching the selection of the [said] arc-shaped part of the cylindrical form [ultrasonic transducer elements].

6. (Amended) The receiving beam-forming method according to claim [5] 27, wherein the acoustic signal [signals received by the multiple ultrasonic transducer elements are] is composed of pulse signals whose pulselength is shorter than the extent of the [multiple] 'n' ultrasonic transducer elements as measured along the direction of a receiving beam [as viewed from said specific direction].

7. (Amended) The receiving beam-forming method according to claim [5] 27, wherein the acoustic signal [signals received by the multiple ultrasonic transducer elements are] is composed of growing waves whose amplitude gradually increases or damped waves whose amplitude gradually decreases.

8. (Amended) [A] The receiving beam-forming method [according to claim 5, 6 or 7] according to claim 27, wherein selection of the scanning cycles for the individual blocks is altered according to the angle between the direction of the receiving beam and the ultrasonic transducer elements arranged in the linear form.

9. (Amended) A receiving beam-forming method comprising [the steps of]:

arranging 'n' ultrasonic transducer elements into a predetermined form;

dividing the plurality of ultrasonic transducer elements into multiple blocks, where 'p' ultrasonic transducer elements are illuminated by an acoustic signal, where 'p' ≤ 'n';

repeatedly sampling signals received by 'p' ultrasonic transducer elements at a specific scanning frequency;

forming sample data for the blocks for a scanning cycle, where a scanning cycle is dependent on the scanning frequency;

[entering sample data obtained by sampling signals received by a plurality of ultrasonic transducer elements arranged in a linear form at a specific scanning frequency;]

storing said sample data [derived from multiple scanning cycles];

[dividing the multiple ultrasonic transducer elements into multiple blocks;]

[reading out the sample data derived from different scanning cycles for the individual blocks;]

[producing a continuous sample data train by shifting the phase of the individual sample data;] and

forming a receiving beam in a specific direction using [the] selected sample data.

10. (Amended) A receiving beam-forming apparatus comprising:

a multiplexer which multiplexes echo signals received by multiple ultrasonic transducer elements arranged in [an arc-shaped] a predetermined form on a receiving transducer, where the echo signals are multiplexed into a [smaller] number of signal

lines, where the number of signal lines is less than the number of the ultrasonic transducer elements;

an A/D converter which repeatedly samples the echo signals received by the individual ultrasonic transducer elements at a specific scanning frequency and outputs complex-valued sample data; and

a signal processor which divides the multiple ultrasonic transducer elements into multiple blocks [according to directions in which receiving beams are formed], selects the sample data derived from different scanning cycles for the [individual] blocks, where a scanning cycle is dependent on the scanning frequency, and forms the receiving beams [in said directions] using the selected complex-valued sample data.

11. (Amended) The receiving beam-forming apparatus of claim 10, wherein the predetermined form is an arc, wherein the arc is obtained by selecting an arc-shaped part of a cylindrical form, wherein a receiving beam-forming direction is rotated by switching the selection of the arc-shaped part of the cylindrical form, wherein a receiving beam-forming direction is rotated by switching the selection of the arc-shaped part of the cylindrical form [said receiving transducer is constructed of multiple ultrasonic transducer elements arranged in a circular form, and said signal processor obtains said multiple ultrasonic transducer elements arranged in the arc-shaped form by selecting an arc-shaped part of the ultrasonic transducer elements arranged in the circular form and rotates receiving beam-forming direction by successively switching the selection of said arc-shaped part of the ultrasonic transducer elements].

19. (Amended) A receiving beam-forming apparatus [in which echo signals received by multiple ultrasonic transducer elements arranged in a linear form are

sampled at a specific scanning frequency to obtain sample data, said receiving beam-forming apparatus] comprising:

a plurality of ultrasonic transducer elements arranged on a predetermined form;

a plurality of ultrasonic transducer elements receiving echo signals, where the transducer elements are sampled at a specific scanning frequency, forming sample data for a scanning cycle, where a scanning cycle is dependent on the scanning frequency;

a memory which stores the sample data [derived] from multiple scanning cycles;

[a sampling plane generator, which produces a continuous sample data train of a sampling plane of a specific angle by shifting the phase of or interpolating the sample data from the multiple scanning cycles;] and

a beamformer which forms a receiving beam in a specific direction using the sample data.

20. (Amended) A receiving beam-forming apparatus which repeatedly samples echo signals received by multiple ultrasonic transducer elements at a specific scanning frequency and forms a receiving beam using sample data obtained by sampling the echo signals in multiple scanning cycles, where a scanning cycle is dependent on the scanning frequency.

Claims 26-33 have been added.